FORM PTO-1390 (REV 11-2000) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY 'S DOCKET NUMBER: FKL 2 089 (1068.0058)

U S APPLICATION NO (If known, see 37 CFR 1 5): 09/857552

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/US99/00653	12/01/1999	12/01/1999

TITLE OF INVENTION: EXTRUDER SCREW NOSE AND FLOW CHANNEL HEAD

APPLICANT(S) FOR DO/EO/US: Gary Robert Burg; Malcom George Marshall

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [ ] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [ ] has been communicated by the International Bureau.
   c. [X] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [ ] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [X] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [X] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [ ] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [ ] Other items or information:

US APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/857552	PCT/US99/00653	FKL 2089 (1068.0058)

21. ☐ The following fees are submitted:	CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1000.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$710.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	11 - 20 =		x **$18.00**	$	
Independent claims	4 - 3 =	1	x **$80.00**	$ 80.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$270.00**	$	
TOTAL OF ABOVE CALCULATIONS =				$ 940.00	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2. +				$	
SUBTOTAL =				$	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$	
TOTAL NATIONAL FEE =				$ 940.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
TOTAL FEES ENCLOSED =				$ 940.00	
				Amount to be refunded:	$
				charged:	$

a. ☐ A check in the amount of $ _____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 07-1725 in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 07-1725 A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO.

Frederick K Lacher
SIGNATURE

NAME

16,502
REGISTRATION NUMBER

EXTRUDER SCREW TIP AND ASSOCIATED FLOW CHANNEL

Technical Field

This invention is directed to methods and apparatus for use with the extrusion of visco-elastomeric material, and more specifically, to the prevention of porosity in an extrudate.

Background Art

It is well known in the art to extrude visco-elastic materials, such as rubber, using a screw extruder and a flow channel head for communicating the rubber through a flow channel from the extruder to a die. At the discharge end of the extruder the visco-elastic material flows over a screw nose into a receiving end of the flow channel. One problem known in the art, for example, in the rubber industry, is porosity, or the formation of bubbles in the material at the discharge end of the extruder where the screw flights terminate. The bubbles are carried in the material through the flow channel and show up as blisters, or porosity in the resulting rubber component after leaving the die.

It is believed the bubbles are formed in the space at the discharge end of the screw flights, because the bubbles show up at positions corresponding to the positions of the screw flights. The bubbles are also believed to result from shrinkage, or the tendency of visco-elastic material to revert to the molecular state of the material prior to the extrusion process, otherwise known as "memory." When the material is being extruded it is stretched, and when the stretching stops, or is decreased, the material will tend to shrink. This reduction in pressure on the material is believed to cause the volatiles in the material to expand and produce bubbles. In the present invention, an enlarged screw nose is provided for preventing this creation of porosity in the extrudate.

Examples of extruders having enlarged screw noses are U.S. Patent No. 4,357,291, which shows a conventional mixing section 26 for an extruder of the type used for extruding ethylene polymers. U.S. Patent No. 5,660,864 shows a bullet nose at the end of a screw section of an injection piston for injection molding of glass fiber reinforced polyester material. U.S. Patent No. 3,846,057 is directed to a reciprocating screw extruder for injection molding of rubber which has a head on the forward end of the screw cooperating with a check ring preventing back flow of the rubber during the injection process. In none of these patents is there a description or showing of an extruder screw with an enlarged screw nose having a conical surface for preventing porosity in the extrudate.

Disclosure of Invention

In accordance with one aspect of the invention, there is provided a screw nose for a discharge end of an extruder having a screw with at least two helical flights rotatable in a cylindrical barrel characterized by the screw nose having an upstream portion of increasing diameter, providing a generally conical surface for decreasing the transition space between the screw nose and the barrel and maintaining pressure on the extrudate at the discharge end.

In accordance with another aspect of the invention, there is provided a method of extruding a shaped rubber component, comprising:

(a) feeding rubber into a cylindrical extruder barrel at a feed end of the extruder,

(b) rotating a screw in said barrel to mix and convey the rubber to a discharge end, characterized by,

(c) restricting the space for the flow of the rubber with a screw nose having an upstream portion of increasing diameter, providing a generally conical surface.

Brief Description of Drawings

Fig. 1 is a schematic cutaway view of an extruder and flow head embodying the invention.

Fig. 2 is a view like Fig. 1 of an extruder and flow head according to the prior art.

Fig. 3 is a cross section of the screw nose of the extruder screw shown in Fig. 1.

Detailed Description of the Invention

Referring to Fig. 1, an extruder-flow head assembly 10 is shown having an extruder 12 connected to a flow head 14 with a flow channel 16 leading to a die (not shown) for forming a component of visco-elastic material, such as rubber.

The extruder 12 has a screw 18 rotatable in a cylindrical barrel 20 with a feed opening 22 at an entrance end 24 of the extruder. A screw nose 26 is provided at a discharge end 28 of the extruder 12. The screw 18 preferably has at least two helical screw flights 30 and 32 and may be rotated by power means, such as a motor (not shown).

Referring to Fig. 2, a prior art extruder 12′ has similar parts to the extruder-flow head assembly 10 of the invention shown in Fig. 1, and the numerals for these parts are designated by the addition of a prime mark. In the prior art extruder 12′ the screw nose 34 has a bullet shape with a diameter D1 which may be the same as the root diameter D2 of the screw 18′.

Referring again to Fig. 1 and to Fig. 3, the screw nose 26 embodying the invention has an upstream portion 36 and a downstream portion 38. The upstream portion 36 has an increasing diameter in the direction of the flow of the rubber providing a generally conical upstream surface 40. The downstream portion 38 of the screw nose 26 has a decreasing diameter in the direction

of the flow providing a generally conical downstream surface 42 which is spaced from a tapered wall 44 of decreasing diameter of the flow channel head 14 in the direction of the flow. Preferably the generally conical upstream surface 40 is inclined at an angle X of 55 degrees to an axis 0-0 of the screw nose and may be inclined from 45 degrees to 65 degrees. The generally conical downstream surface 42 is inclined to the axis 0-0 at an angle Y of 40 degrees and may be inclined from 35 degrees to 45 degrees, depending on the angle Z, that the tapered wall 44 is inclined to the axes 0-0. Preferably the angle Y is equal to the angle Z.

A transition space 46 is defined by the conical surface 42 of the downstream portion 38, the conical surface 40 of the upstream portion 36, a tapered wall 44 of the flow head channel 14 and the cylindrical barrel 20 of the extruder 12 as shown in Fig. 1. In the prior art extruder 12′, the transition space 48 is defined by the cylindrical bullet nose screw nose 34, the tapered wall 44′ of the flow channel head 14′ and the cylindrical barrel 20′.

In operation of the extruder embodying the invention, a visco-elastic material, such as rubber, is fed into the extruder 12 through the feed opening 22 and the screw flights 30 and 32 propel the rubber toward the discharge end 28 of the extruder 12. As the screw 18 is rotated, the screw flights 30 and 32 and the cylindrical barrel 20 are in working engagement with the rubber, which is pulled and stretched in tension as it is moved from the feed opening 22 to the discharge end 28 of the extruder. This working increases the pressure on the rubber and raises the temperature.

In the prior art extruder shown in Fig. 2, the working engagement, including the stretching and mixing of the rubber is substantially reduced at the discharge end 28′ where the rubber is moved into an enlarged transition space 48 and past the screw nose 34 which has a configuration of a bullet with a diameter D-1 substantially the same as the root diameter D2 of the screw 18′. The pressure on the rubber in the enlarged transition space 48 is reduced where it is believed volatiles in the rubber expand and cause bubbles. The rubber then flows through the flow channel 16′ to a die (not shown). The shaped rubber material is then exposed to the atmosphere where it is believed porosity and blisters in the surface of the extruded material are formed.

With the apparatus of this invention shown in Figs. 1 and 3, the screw nose 26 has an upstream portion 36 with a conical surface of increasing diameter in the direction of the flow for engaging the rubber flowing from the helical screw flights 30 and 32 and urging the rubber into working engagement with the wall of the cylindrical barrel 20. This working engagement

maintains the pressure on the rubber and prevents expansion of the volatiles in the rubber. After passing over the conical surface 42 of the upstream portion 36 of the screw nose 26, the rubber flows over the downstream portion 38 which has a decreasing diameter in the direction of flow with a surface 42 at the angle Y, in substantially parallel relation to the tapered surface 44 of the flow channel head 14 which is inclined at an angle Z relative to the axis 0-0 of the screw nose. With this configuration the rubber is confined to the space between the tapered surface 44 and the conical surface 42 and maintained in working engagement with these surfaces 44 and 42 of the tapered wall and upstream surface, thereby maintaining pressure on the rubber and preventing the formation of bubbles by expansion of the volatiles in the rubber material. The rubber material then flows through the flow channel 16 of the flow head 14 which has a generally constant sectional area to a die (not shown) where it is formed in the final shape without expansion of the volatiles, providing a bubble free, smooth surfaced extrudate.

While a certain representative embodiment have been shown for the purpose of illustrating the invention, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention.

Having thus described the invention, it is now claimed:

CLAIMS

1. An extruder screw nose for a discharge end of an extruder having a screw with at least two helical flights rotatable in a cylindrical barrel for propelling an extrudate material from an upstream portion of said barrel to a downstream portion characterized by said screw nose having an upstream portion of increasing diameter in the direction of flow of said extrudate providing a generally conical surface for decreasing a transition space between said screw nose and said barrel and maintaining working engagement with said extrudate to maintain pressure on said extrudate at said discharge end.

2. The extruder screw nose according to claim 1 further characterized by having a downstream portion of decreasing diameter in said direction of flow providing a generally conical surface generally parallel to a converging tapered wall of an adjacent flow channel block for maintaining working engagement with the extrudate and maintaining the pressure on the extrudate at said discharge end.

3. The extruder screw nose according to claim 1 further characterized by said upstream portion of increasing diameter having a conical surface disposed at an angle of 45 degrees to 65 degrees relative to the axis of said screw nose.

4. The extruder screw nose of claim 3 further characterized by said angle of said conical surface of said upstream portion being about 50 degrees.

5. The extruder screw nose according to claim 2 further characterized by said generally conical surface of said downstream portion being at an angle of 35 degrees to 45 degrees relative to the axis of said screw nose.

6. The extruder screw nose of claim 5 further characterized by said angle of said generally conical surface of said downstream portion being at an angle of about 40 degrees.

7. A method of extruding a shaped visco-elastic component, comprising:

(a) feeding a visco-elastic material into a cylindrical extruder barrel at a feed end of said extruder,

(b) rotating a screw to mix and provide working engagement of said screw with said cylindrical extruder barrel characterized by,

(c) maintaining working engagement of said screw and said extruder barrel at a discharge end of said extruder by confining the flow of said visco-elastic material through a transition space between a screw nose on said screw and said cylindrical extruder barrel

wherein said screw nose has an upstream portion of increasing diameter in the direction of flow of said material providing an upstream generally conical surface.

8. The method of claim 7 further comprising maintaining working engagement of said visco-elastic material from said upstream portion to a downstream portion of decreasing diameter in said transition space wherein a flow channel head with a tapered wall is attached to said extruder characterized by conveying said visco-elastic material in working engagement with said downstream portion of said screw nose and said tapered wall of said flow channel head.

9. An extruder and flow channel head assembly comprising an extruder having a cylindrical barrel with a feed end and a discharge end, said discharge end being attached to a flow channel head containing a flow channel for carrying rubber from said extruder to a suitable die, a screw nose on said extruder screw positioned in a transition space at said discharge end of said barrel characterized by said screw nose having a radially expanding upstream portion providing a conical surface of increasing diameter in the direction of flow of said rubber for maintaining said rubber in working engagement with said screw nose and said cylinder wall, whereby the pressure on said rubber is maintained in said transition space.

10. An extruder and flow head assembly according to claim 9, further characterized by said screw nose having a downstream portion with a conical surface of decreasing diameter in the direction of flow of said rubber spaced from an opposing tapered wall of said flow channel head to maintain working engagement of said rubber with said conical surface of said screw nose and said tapered wall of said flow channel head whereby pressure on said rubber is maintained to prevent expansion of volatiles in said rubber.

11. An extruder and flow head assembly according to claim 10, further characterized by said flow channel having a generally constant cross sectional area from said tapered wall of said flow channel head to a discharge end of said flow channel head to maintain pressure on said rubber and provide time for volatiles in said material to be dissolved before ejection from said flow channel head.

AMENDED CLAIMS

[received by the International Bureau on 9 November 1999 (09.11.99);
original claims 1-11 replaced by amended claims;
1-11 (2 pages)]

1. An extruder having a screw with at least two helical flights rotatable in a cylindrical barrel for propelling an extrudate material from an upstream portion and an extruder screw nose at a discharge end of said extruder of said barrel to a downstream portion characterized by said screw nose having an upstream portion of increasing diameter in the direction of flow of said extrudate providing a generally conical surface for decreasing a transition space between said screw nose and said cylindrical barrel and maintaining working engagement with said extrudate to maintain pressure on said extrudate at said discharge end.

2. The extruder according to claim 1 further characterized by said screw nose having a downstream portion of decreasing diameter in said direction of flow providing a generally conical surface generally parallel to a converging tapered wall of an adjacent flow channel block for maintaining working engagement with the extrudate and maintaining the pressure on the extrudate at said discharge end.

3. An extruder screw nose for a discharge end of an extruder having a screw with at least two helical flights rotatable in a cylindrical barrel for propelling an extrudate material from an upstream portion of said barrel to a downstream portion of said barrel characterized by said screw nose having an upstream portion of increasing diameter in the direction of the flow of said extrudate providing a generally conical surface disposed at an angle of 45 degrees to 65 degrees relative to the axis of the screw nose and a downstream portion of decreasing diameter in said direction of flow providing a generally conical surface generally parallel to a converging tapered wall of an adjacent flow channel block.

4. The extruder screw nose of claim 3 further characterized by said angle of said conical surface of said upstream portion being about 50 degrees.

5. The extruder screw nose according to claim 3 further characterized by said generally conical surface of said downstream portion being at an angle of 35 degrees to 45 degrees relative to the axis of said screw nose.

6. The extruder screw nose of claim 5 further characterized by said angle of said generally conical surface of said downstream portion being at an angle of about 40 degrees.

7. A method of extruding a shaped visco-elastic component, comprising:

(a) feeding a visco-elastic material into a cylindrical extruder barrel at a feed end of said extruder,

(b) rotating a screw to mix and provide working engagement of said screw with said cylindrical extruder barrel characterized by,

(c) maintaining working engagement of said screw and said extruder barrel at a discharge end of said extruder by confining the flow of said visco-elastic material through a transition space between a screw nose on said screw and said cylindrical extruder barrel wherein said screw nose has an upstream portion of increasing diameter in the direction of flow of said material to a diameter not greater than the diameter of said cylindrical extruder barrel providing an upstream generally conical surface.

8. The method of claim 7 further comprising maintaining working engagement of said visco-elastic material from said upstream portion to a downstream portion of decreasing diameter in said transition space wherein a flow channel head with a tapered wall is attached to said extruder characterized by conveying said visco-elastic material in working engagement with said downstream portion of said screw nose and said tapered wall of said flow channel head.

9. An extruder and flow channel head assembly comprising an extruder having a screw and cylindrical barrel with a screw flight extending from a feed end to a discharge end, said discharge end being attached to a flow channel head containing a flow channel for carrying rubber from said extruder to a suitable die, a screw nose on said extruder screw positioned at the end of said screw flight in a transition space at said discharge end of said barrel characterized by said screw nose having a radially expanding upstream portion providing a conical surface of increasing diameter in the direction of flow of said rubber for maintaining said rubber in working engagement with said screw nose and said cylinder wall, whereby the pressure on said rubber is maintained in said transition space.

10. An extruder and flow head assembly according to claim 9, further characterized by said screw nose having a downstream portion with a conical surface of decreasing diameter in the direction of flow of said rubber spaced from an opposing tapered wall of said flow channel head to maintain working engagement of said rubber with said conical surface of said screw nose and said tapered wall of said flow channel head whereby pressure on said rubber is maintained to prevent expansion of volatiles in said rubber.

11. An extruder and flow head assembly according to claim 10, further characterized by said flow channel having a generally constant cross sectional area from said tapered wall of said flow channel head to a discharge end of said flow channel head to maintain pressure on said rubber and provide time for volatiles in said rubber to be dissolved before ejection from said flow channel head.

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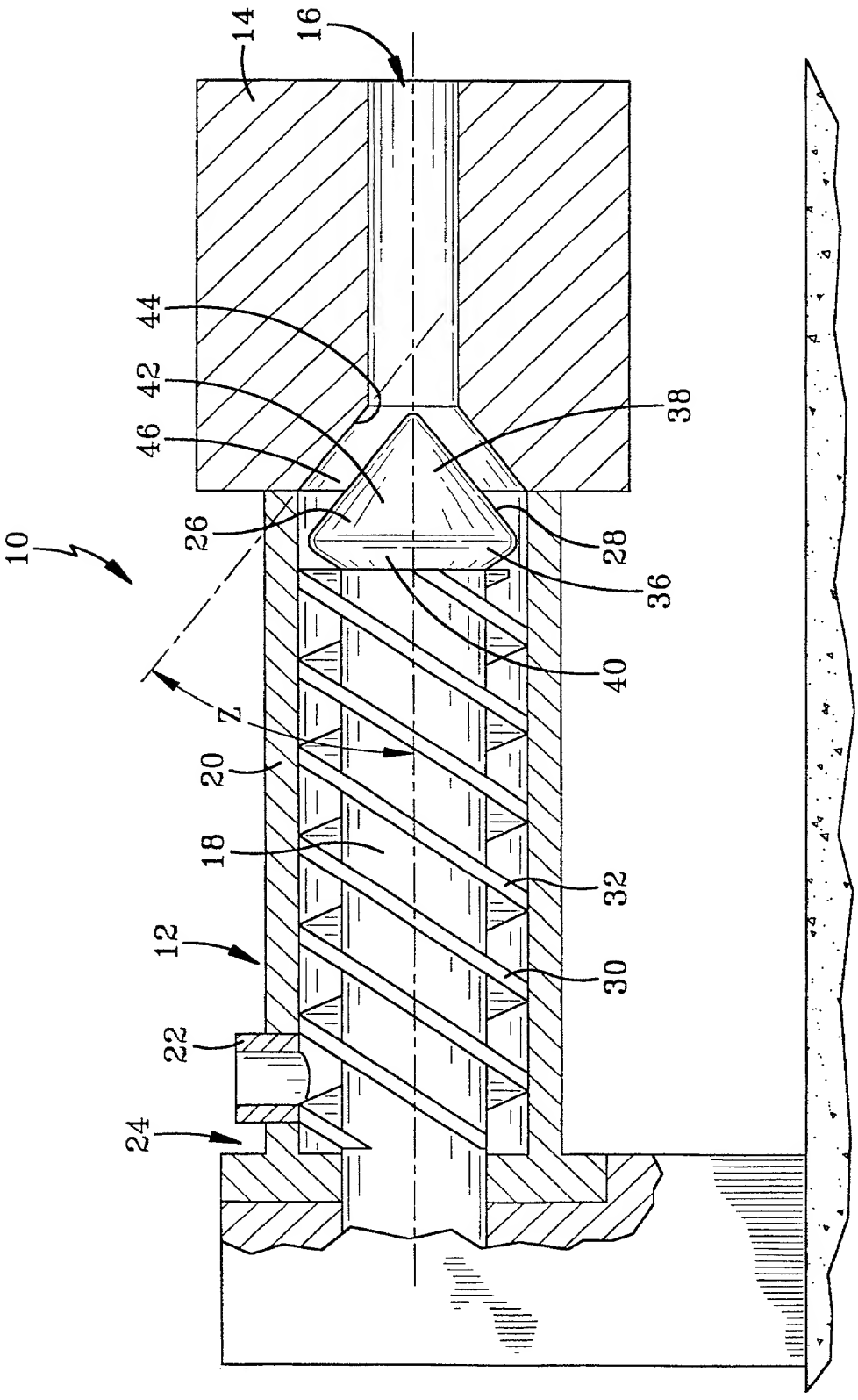

FIG-1

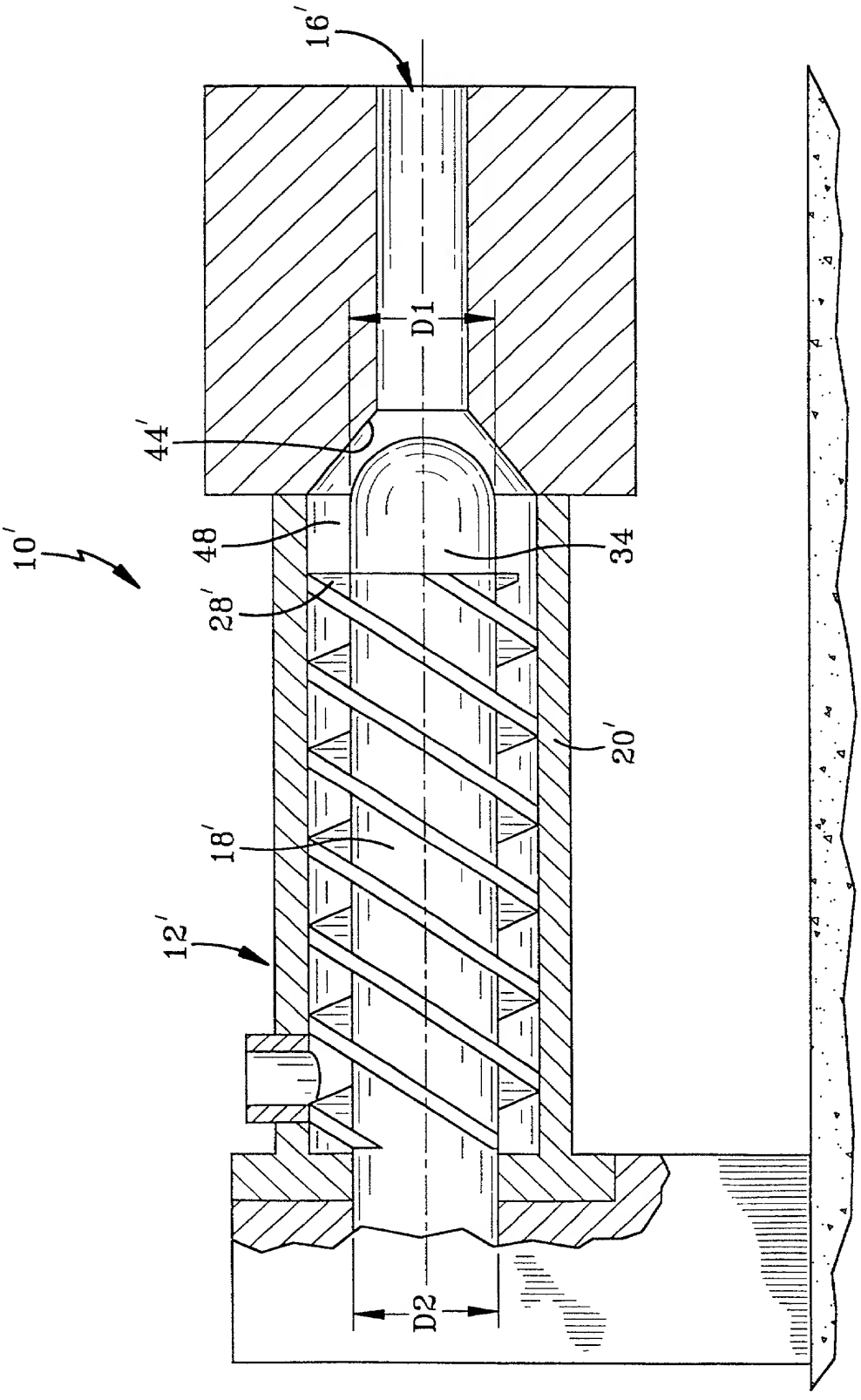

FIG-2
PRIOR ART

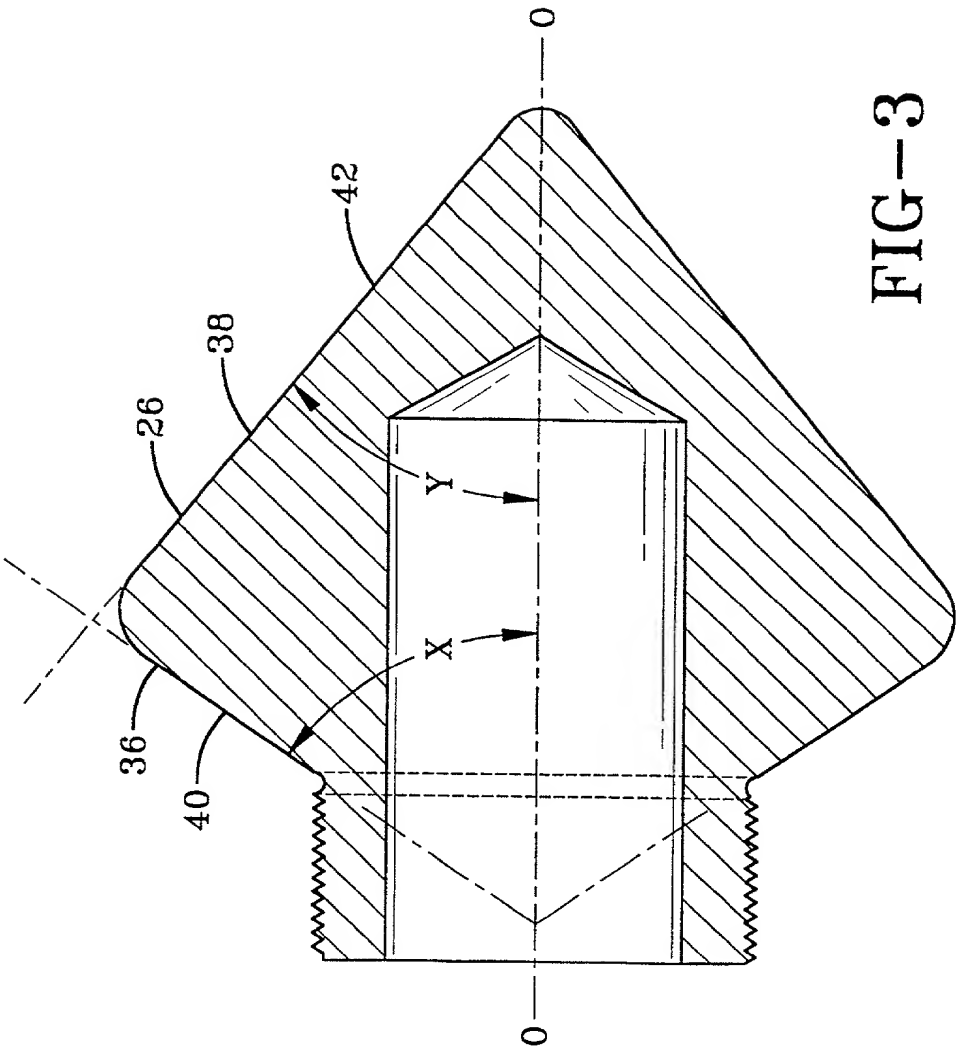

FIG-3

Docket No. DN19990001

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **EXTRUDER SCREW NOSE AND FLOW CHANNEL HEAD** the specification of which (check one)

X is attached hereto.

was filed on January 12,1999 as Application Serial No. PCT/US99/00653 and was amended on February 19, 2001 (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in 37 C.F.R. §1.56.

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application(s) listed below:

(Application Serial No.) (Filing Date)

(Application Serial No.) (Filing Date)

I hereby claim the benefit under 35 U.S.C. §120 of any United States application(s) or §365 of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose material information as defined in 37 C.F.R. §1.56 which become between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	(Filing Date)	(Status)(patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status)(patented, pending, abandoned)

POWER OF ATTORNEY

As named inventor(s), I or we hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Frederick K Lacher	Registration No.	16,502
Robert W Brown	Registration No.	24,499
Roger D Emerson	Registration No.	33,169

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statement may jeopardize the validity of the application or any patent issuing thereon.

Full name of sole or first inventor (given name, family name) Gary Robert Burg
Inventor's signature Gary Robert Burg Date: June 1, 2001
Residence: Massillon, Ohio 44646 Citizenship U.S.A.
Post Office Address: 6433 Dromoland Circle N. W., Massillon, Ohio 44646

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Inventor's signature Malcolm George Marshall Date June 1, 2001
Residence: Wadsworth, Ohio 44281 Citizenship U.S.A.
Post Office Address: 122 Apple Drive, Wadsworth, Ohio 44281

Full name of third joint inventor (given name, family name)
Inventor's signature: _____ Date: _____
Residence: _____ Citizenship U.S.A.
Post Office Address: _____

Full name of fourth joint inventor, if any (given name, family name): _____
Inventor's signature: _____ Date _____
Residence: _____ Citizenship: U.S.A.
Post Office Address: _____

☐ Additional inventors are being named on separately numbered sheets attached hereto.

SEND CORRESPONDENCE TO:	DIRECT TELEPHONE CALLS TO:
Frederick K Lacher c/o Robert W Brown The Goodyear Tire & Rubber Company Patent Dept., D/823 1144 East Market Street Akron, Ohio 44316	Frederick K Lacher (330) 535-5445

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